Thermophysical Properties of Molten Metal-Based Materials

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The measurements of the thermophysical properties of various alloy systems present different problems which may require extensive modifications to standard procedures. The obvious problems include relatively high measurement temperatures, high constituent vapor pressures, containment problems, convection and segregation considerations, volume changes during melting/solidification, and sample deformation - both in the solid and molten states.

At TPRL, Inc., we have been involved with molten materials since 1982 (18 years ago). We have measured alloys based on Al, Be, Cu, Fe or Mg as the major constituent as well as semiconductors and generated about 50 reports. Because the casting industry is very competitive and reliable data are scarce, almost all these reports are proprietary.

It soon became apparent that the thermophysical properties of Al alloys are relatively less difficult to measure. This is due to moderate T_L and T_S values, simple containment, low vapor pressure and the very large differences in the magnitudes of the properties in the molten and solid states. In order to demonstrate these qualities we measured the properties of four types of wrought Al alloys, namely 1100-F, 2024-T4, 6061-T6 and 7075-T6. 1XXX are used in the electric and chemical industries, 2XXX and 7XXX are widely used in aircraft and 6XXX are used for architectural extrusions. The large changes in thermal properties resulting from different tempering conditions were clearly evident.

However, the properties of the casting Al alloys (identified as XXX.X) are obviously of most interest to the casting community. In particular, the 3XX.X alloys which have Si as the major alloying constituent along with Cu and/or Mg, are extensively used in casting. In fact, over 80% of Al alloy casting involves these alloys. Therefore, the properties of A356 are also presented and discussed.